PUBLICATION 485

Growing Vegetable Transplants

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INTRODUCTION

The frost-free period in Southern Ontario for growing vegetable crops is quite short, ranging from 180 to 220 days. This short season forces growers to produce early crops, usually best achieved through the field-setting of well grown and properly-aged transplants. The use of transplants, grown under protective cover when outdoor temperatures are still unfavorable insures the producer of a good plant stand without the risks of field seeding and increases the length of the growing season by 3 to 8 weeks. Growers who produce their own transplants realize several advantages:

(a) suitable transplants are ready when needed through control over timing and growing conditions
(b) plants can be held in relatively good condition even if inclement weather delays field planting
(c) specific cultivars can be raised which are unobtainable as transplants from southern growers — e.g., vine crops, lettuce, eggplant and celery
(d) container-grown plants with properly developed root systems can be used down to mini-cell size since shipping, with its inherent difficulties, is unnecessary
(e) the possibility of importing foreign weeds and diseases along with the transplants is eliminated; growers can exercise control over seed sources

Although many people are interested in growing plants for their own use, there is room in Ontario for a sizeable industry which could produce healthy transplants as a profitable seasonal business. Such a business would require only a modest investment and would be particularly welcome in regions with concentrated commercial vegetable hectarage for either processing companies or the fresh market.

Growing healthy, properly sized and aged transplants, however, requires a knowledge of the fundamentals of plant science as well as skill and continuous care. This publication provides basic information on greenhouse structures, growing media, seeding and transplanting techniques, plant management and disease and pest control for the production of healthy vegetable transplants.

Whether one grows one hectare, two square metres of just one flat for the home garden, good-quality plants are essential for success in vegetable production.

DEFINITIONS AND TERMINOLOGY

Seedling — A young plant grown directly where seeded, before transplanting.
Transplanting — Replanting seedlings into pots, blocks, flats or beds. The term "pricking-off" (or pricking-out) is used by some gardeners.
Transplant — The plant which has been transplanted.
Plug — Small plant produced in "mini-celled" trays (288/flat or more).
Plants — The finished transplants, ready for field planting. Some vegetables like melons are not transplanted, but seeded directly in a pot or block. These are "seedlings" after emergence, and "plants" when ready for field planting.
Field Planting (or Setting) — The final planting for crop production. Sometimes the term transplanting is used for field planting, causing confusion.

Cultivar — This term is replacing the word "variety". Cultivar refers specifically to a uniform plant group, whether it is open-pollinated, seed-propagated, a hybrid, or a vegetatively propagated stock. For example, there is a yellow variety of tomato with several cultivars available on the market.

Growing Medium — Any single medium or mix supporting plant roots, containing either soil or so-called "artificial" ingredients, then referred to as a soilless mix.

PLANT-GROWING STRUCTURES

Vegetable transplants can be grown in various types of structures such as coldframes, hotbeds, and glass or plastic greenhouses. The choice depends not only on one's budget, but also on the volume of plants to be grown and on the suitability of the particular structure for other uses.

Coldframes and Hotbeds

Coldframes in general are single, inexpensive structures, mostly plastic-covered with 1 × 2m (3 × 6 ft.) sashes placed on frames holding single or double rows. They depend entirely on the sun for heat, unless one has a source for horse manure, which then is stacked deep enough in the bottom of each frame to ferment. This fermentation releases both heat and carbon dioxide, but releases ammonia as well, which can be detrimental to plant growth at times. The system is rather labor intensive and now rarely used. Soil temperatures generally are too low in coldframes for starting early transplants successfully, but may be used effectively later in the season or employed to hold or to harden plants. Therefore,

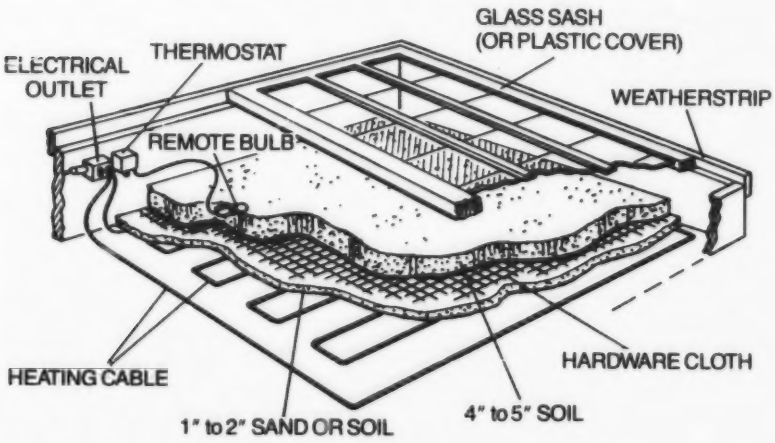


Figure 1. This diagram illustrates basic construction details of an electrically heated hotbed. If needed for proper drainage, layers of gravel or cinders and vermiculite (not shown) may be used beneath the cable.

one is advised to use a hotbed instead — a modified coldframe with added heat, utilizing heating pipes (hot water or steam), electric soil cables or heat-mats. Either system engages a thermostat for accurate temperatures. Unless the added heat is supplied from the bottom, soil temperatures generally are too low for early, good plant growth.

Overall, growing quality transplants in hotbeds requires more skill and constant attention, as the limited growing space allows little room for error.

GREENHOUSE STRUCTURES

Greenhouses covered with either glass or plastic offer several advantages over coldframes and hotbeds. In inclement weather they not only protect workers but make plant handling easier and more convenient. In addition, extra lighting can extend working hours in peak periods. Furthermore, seedlings and transplants can be inspected more easily and disease and pest control accomplished much better and more efficiently. The control of growing temperatures, moisture and ventilation in most houses is also maintained more effectively.

The higher cost of greenhouse construction over hotbeds and coldframes is well justified. A better, more-uniform end product is achieved with less effort, and expenditure can be spread over several seasons.

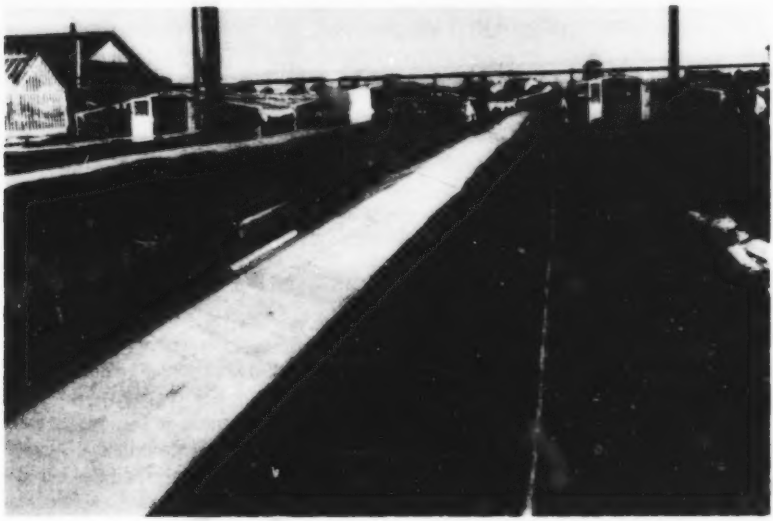


Figure 2. Heated coldframes filled with flats ready to be pulled by hand and crated for field planting.

Figure 3. "Pricking-off" seedlings in ground beds, a very labor-intensive operation.

Standard Greenhouses

Simple, ordinary greenhouses are quite satisfactory for plant growing. However, most growers who invest in a standard greenhouse feel that all-season crop production is a better return on their investment; therefore, most plant growers have less-expensive and less-elaborate houses, with smaller heating systems than are needed for midwinter production. Often a small standard glass house is used as a "starting" house for seeded flats and for growing seedlings until transplanting.

Plastic Greenhouses

These are widely used for plant production. They are relatively inexpensive and large enough to allow mechanized handling of soil, flats and plants. A plastic greenhouse should be constructed with walls high enough and doors large enough to allow easy entry with tractors and equipment. Sidewalls should be removable for maximum ventilation in late spring.

Ontario Ministry of Agriculture and Food Publication 40, *Plastic Greenhouses*, and Agriculture Canada Publication 1337, *How to Build a Plastic Crop Shelter or Greenhouse*, give descriptions and illustrations of many types.

Ventilation is even more important than in a glass house. Do not cut corners; supply adequate ventilation.

Also refer to OMAF Publication #65, *Energy Conservation in Ontario Greenhouses*.

GROWING MEDIA

Growers often prefer to use different soil mixes or media for each specific purpose: (a) one to produce seedlings (seed-sowing medium); (b) another in which to prick-off seedlings; (c) a very specific medium for multi- or small-celled plant trays. For the successful production of vegetable plants, ordinary soil, as it exists in gardens or fields, is usually not a satisfactory growing medium for use in seed flats or beds, since it generally does not have the proper structure for optimum plant growth.

A well-prepared compost[1] which is high in organic matter is always an excellent material to use when making up a greenhouse soil mix, but few establishments are set up for, or bother preparing, an "old-fashioned" compost pile.

Today many materials are used for growing plants; personal preference, cost and availability of individual ingredients dictate the media in use.

[1]For detailed information see OMAF Factsheet #79-052, *Composts and Soilless Mixes for Transplants*.

Table 1 Characteristics of Soil and Soilless-Media Ingredients*

Material	Advantages	Disadvantages
Field Soil	Relatively inexpensive. Holds water and nutrients.	Heavy; often contains pathogens. Clay soils usually drain poorly and are variable in fertility. Will crust. Requires pasteurization.
Sand	Relatively inexpensive. Improves drainage. (Medium to coarse grades are best.)	Low nutrient and water-holding capacity. Heavy to handle.
Peat Moss	Holds nutrients and water.	May be strongly acidic. May contain weeds.
Vermiculite	Holds nutrients and water. Supplies potassium. Provides aeration. Light-weight.	Compacts when too wet.
Perlite	Provides aeration. Light-weight, sterile, and neutral in pH. Does not decay.	Low nutrient and water-holding capacity. Floats to surface of container. Dusty when mixing.
Manure compost	Good source of organic matter. Usually available free.	Fresh manure is high in ammonia and can burn. Variable in composition. May contain excess salt.
Garden Compost	Excellent source of organic matter. Utilizes various "free" waste materials.	Labor-intensive preparation; not always available in time.

* *Adapted from Univ. of Illinois Circular 884*

There are mixes containing soil, which must be sterilized before using, and soilless mixes consisting of so-called "artificial" or "synthetic" materials.

Soil media often cost less initially. The labor and problem of sterilizing and handling the heavy soil mixes make soilless mixes more practical in the long run. Generally the "artificial" mixes contain peat moss, vermiculite, perlite and sand in varying proportions. Soil mixes in turn may also contain the aforementioned ingredients as soil conditioners (Table 1).

Detailed Description of Major Ingredients of "Soilless Mixes"

Vermiculite is a light-weight, sterile, expanded mica that contains a considerable amount of potassium and magnesium. Its high nutrient-holding ability has a buffering capacity that reduces injury from excess salts. Horticultural vermiculite is preferable to construction grades that may include contaminants and excessively large particles.

Perlite is a light-weight, sterile, expanded volcanic rock. Unlike vermiculite, it provides no nutrients for plant growth, but it does provide superb aeration and does not turn soggy when overwatered.

Horticultural *Peat moss* is usually sold as a medium to fine-grade in 4 and 6 cu. ft. compressed bales, but some brands are loosely packed in plastic bags. Beware of cheaper brands; they often contain pieces of wood and root material requiring extra sifting, or they may consist of over-decomposed material provid-

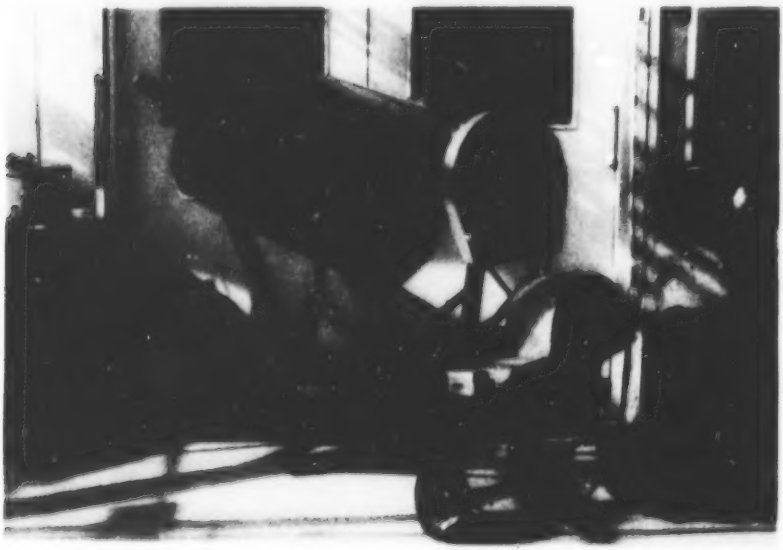


Figure 4. Common "cement-mixer" used to properly prepare smaller quantities of soil mix.

ing inadequate drainage. Peat moss when freshly used from the bale should be free from undesirable pathogens.

Soil-Peat-Sand Mixture

A widely used mixture for flats and beds is prepared by thoroughly mixing together seven parts, by volume, of fertile sandy or light clay loam, three parts of horticultural peat, and two parts of sharp sand. The loam, peat, and sand supply plant food, organic matter, and good aeration. If not previously passed through a shredder, sifting may be necessary for the sand and loam, but not for the peat.

This mixture will not be as high in plant nutrients as the compost, and additional plant feeding is necessary after 2–3 weeks. Since most soils vary considerably in their chemical and biological content, it is impossible to make fertilizer recommendations that will meet all the requirements. It is wise, therefore, to obtain a chemical analysis of the soil before applying nutrients. A number of excellent soluble fertilizers are available for supplying nutrients to young plants.

Seed-Sowing Media

Since standard soil mixes are heavy and usually not adequately drained for germinating seeds, a special seed-sowing medium is often used. This may consist of a completely soilless mix or a sterilized soil mixed with a conditioner.

Figure 5. A small toothed-belt type soil shredder. *(Photo courtesy of Spraymotor Ltd., London, Ontario).*

Vermiculite can be used alone or in combination with soil. Heavily rooted seedlings produced in vermiculite can be easily removed with minimum breakage of roots. Some growers prefer to sow seed in a 1/2-inch layer of vermiculite placed on a soil mix in a flat. Soil or soil mixes should have the desired physical characteristics for successful use as a seedling mix. Mixtures of equal parts of soil, sand, and peat are good media. Pure sand is not generally used as it has low moisture-holding capacity. Many growers sow the seeds on a soil mix and then cover them with a light layer of sand, vermiculite, or finely-shredded peat. It pays to have the medium sufficiently light for maintaining control over the seedling growth by simply withholding water. Mixes of vermiculite and perlite are sterile and free of organic matter, and thus do not need any additional treatment for disease control.

Generally it is advisable to incorporate a fungicide with your first watering (see section in disease prevention, page 36).

Table 2 Example of Soilless Mix (Peat-Lite Mix for Growing Plants)

Material	Amount to Make		
	1 cubic yard	2 bushels	1m³
Shredded sphagnum peat moss	11 bushels[a]	1 bushel	1/2 m³
Horticultural vermiculite No. 2, 3 or 4	11 bushels	1 bushel	1/2 m³
Ground limestone (dolomitic preferred)	10 pounds	1 pound	5 kg
20% superphosphate (powdered)	2 pounds	4 ounces	1 kg
or			
56% triple superphosphate	1 pound	2 ounces	500 g
Calcium or potassium nitrate, and	1 pound		500 g
Fritted trace elements	2 ounces		50 g
or			
Fertilizer (5-10-10)	5 pounds	8 ounces	2.5 g
Wetting agent (nonionic)	3 ounces[b]	. . .[c]	80 g[b]

[a] *Level, full bushels; not packed*
[b] *Mix in 10 gal (50L) of water, then sprinkle over 1 yd³ (m³) of mix*
[c] *Apply 1 gal (5L) of solution (3 oz/10 gal)*

For more details, see *Cornell Peat-Lite Mixes for Commercial Plant Growing.*

Also see OMAF Factsheet *Soilless Mixes*, Order No. 83-021, and Agriculture Canada Publication 1726/E *Artificial Media in Horticulture — Their Formulation and Fertilization.*

1. dimmer/on-off switch to regulate temperature
2. check light
3. food-warmer plate
4. cake pan for water
5. seed sack (more than one can be treated at a time)
6. probe thermometer
7. 4-mil or 6-mil (preferable) plastic covering for entire box
8. lath framing
9. 4-mil or 6-mil (preferable) plastic door
10. screen-wire shelf or old refrigerator shelf (more than one can be inserted)
11. single piece of plywood
12. hooks to hold door shut

Plant-Growing Media

Many different growing mixtures are used in growing vegetable seedlings for either home gardens or commercial fields. No single mixture can be recommended as ideal for all situations, not only because of variable costs and availability of materials, but also because the media selection is dependent on the crop to be grown and the various management systems in use.

Good soil mixes commonly consist of one part soil and one or more parts conditioner. A conditioner is used to improve the physical properties of the medium, and may consist of sand, peat, perlite, vermiculite, or any combination of these materials. Growing mixes must contain a nutrient level which can sustain plants for several weeks without causing deficiencies. Media to be used for plant raising, therefore, must be tested for soluble-salt content, general fertility level and correct pH (6.0 to 6.8). Soil-test containers and appropriate forms are available from OMAF agencies. Beware of used greenhouse or potting soils and sewage sludge. Frequently they are high in soluble salts that may kill or severely stunt seedlings.

Many prepared growing mixes are readily available through commercial channels. It is advisable to test a small quantity of a specific medium for suitability to your individual plant production before purchasing large quantities. Considerable differences exist in fertility, ingredients and water-holding capacity of the media.

When producing transplants in small-celled plugs the selection of the growing material becomes even more critical.

SEEDING

Cultivar (Variety) Selection

Ontario Ministry of Agriculture and Food Publication 363, *Vegetable Production Recommendations*, lists recommended cultivars. It is revised annually, based on trials at various locations across the province. Crops for specific markets and for certain locations are seldom listed. Advice will be given by OMAF personnel or crop advisors in each district. The choice often depends on personal experience combined with local test results by public institutions. Seed catalogues give assistance also, but usually are only a general guide.

Seed Quality and Quantity

A successful operation depends on good-quality seed of current stock with high seed vigor and a uniform emergence rate. Buy the best obtainable seed certified and pre-treated against undesirable fungi detrimental to healthy plant growth.

Major seed companies carry size-graded commercial seed lots and now offer enhanced, pre-treated seeds such as high-tech, quick-pill, split-pill, ultraseed

and Superfrax, to guarantee excellent germination and emergence. Future commercial transplant production will rely entirely on enhanced* seeds. Tables 3 and 4 show seed requirements, recommended treatments and transplant management under a protected environment.

When to Sow Seeds

Seeding date is determined by the date of proposed field setting. Field setting is dictated by the crop's hardiness and the climate in your area (see Figure 6 and Tables 3 and 4).

**Gravity graded, precision sized and presoaked in nutrient solutions, dried again; at times, osmo-conditioned and sometimes pelleted with or without additional nutrients. Some companies use growth promoters and stimulants.*

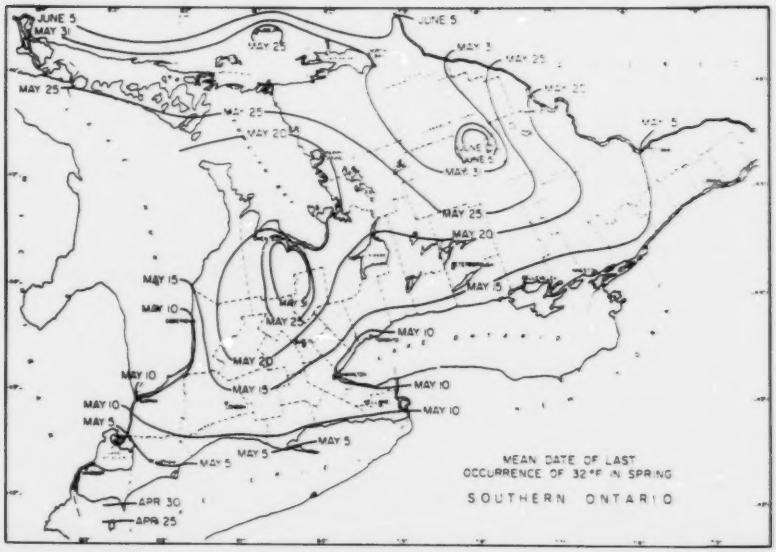


Figure 6. Map of Southern Ontario giving average dates of last 0°C freeze in spring. There is a 50% chance that a freeze will occur after the dates shown.

Table 3 Information on Most Commonly Transplanted Crops in Seed Flats

Crop and Season	Expected Seed Life Years (2)	Ease of trans-planting (1)	Approximate plants per 10 g of seed	Seed for one ha (g)	Seedling to trans-planting (weeks)	Seeding depth (mm)	No. of Seed per 5 cm of row	Row Width cm	Frost Tolerance in Field (4)
Cabbage — early	3–4	1	1,500	280	6–7	12	15	5	
late		1	1,500	280	5–6	12	18	5–8	1
Brussels sprouts	3–4								
Broccoli	3–4	1	1,500	280	5	6	18	5–7	
Cauliflower	3–4					3		8	2
Celery — early	5	2	5,000	140	10	3	40		
late		2	5,000	140	5–6	3	20	6	2
Eggplant	3–4	3	850	350	6–8	6		5–7	4
Lettuce	5–6	1	3,500	210–280	5–7	3–6	30	8	4
Muskmelon and Cucumber	4–5	4	180	440	4–5	18	3	7–10	4
Onion — Spanish	1	2	1,200	130	8–10	6	18		1+
Pepper	2–3	2	500	560	6–9	6	20	7–10	3
Tomato	3–5	1	1,200	280	5–7	6	20	5–8	4
Squash	3–4	4	100	210	3–4	18–25	(3)	—	4

(1) Ease of planting: Group 1 — easy; form new roots quickly. Group 2 — moderately easy. Group 3 — difficult; require special care. Group 4 — not to transplant.

(2) Under good storage conditions

(3) Directly into pots or bands

(4) 1 — tolerant, 3 — susceptible

Table 4 Recommended Germination and Growing Conditions

Crop	Optimum Soil Temperature Range for Germination °C	Days to Emerge (a)	Plant Growing Temperature °C Day (b)	Night	Minimum Space For Early Transplants (cm)	Hardening or Special Treatment
Cabbage	21–27	4–5	16–21	10–16	7 × 7	
Brussels Sprouts	21–27	5	16–21	10–16	7 × 7	10–13°C (50 to 55°F) for 10 days
Broccoli	21–27	5	16–21	10–16	7 × 7	
Cauliflower	21–27	5–6	16–21	13–16	7 × 7	
Celery					5 × 7	low moisture; 16°C (60°F) low temperature (4–16°C (40 to 60°F) can cause "bolting")
Eggplant	24–29	6–8	21–27	18–21	10 × 10	18–21°C (65–70°F)
Lettuce	21	2–3	13–21	7–13	5 × 5	lower both temperature and moisture
Muskmelon	24–35	3–4	21–27	16–21	7 × 7	reduce moisture only
Cucumber		2–5	21–27	16–21	7 × 7	
Onion	18–25	4–5	16–21	7–13	—	4–7°C (40-45°F)
Pepper	24–29	7–8	18–27	16–21	5 × 7	16°C (60°F) reduce moisture
Tomato	24–27	6	16–21	16–18	7 × 7	16°C (60°F) reduce moisture
Squash	24–35	3–4	21–27	16–21	7 × 7	reduce moisture only

(a) at optimum soil temperature range;

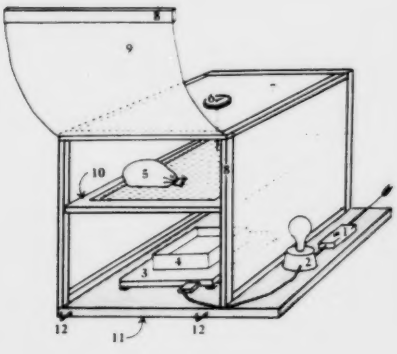
(b) use lower temperatures on cloudy days

Plants started during winter or early spring in a greenhouse or growing frame under unfavorable environment conditions require much longer growing times than indicated in the tables.

Some people believe that older transplants (grown for longer than the recommended time) will result in earlier yield because less growing time will be required in the field. Considerable research and field tests, however, have proved that older transplants actually result in spindly plants, delayed maturity, rough fruit and decreased yields with poorer grades. Their use will also lengthen the total growing period and increase costs. In tomatoes, for example, over-aged transplants will result in plants with stunted growth and poor fruit development. The exception to this is transplants specifically treated for exceptionally early fresh-market plantings.

Germination Requirements

Specific temperature ranges for best germination results of the major vegetable crops are outlined in Table 4. Temperatures below or above the optimum ranges will not only increase the time requirements, but will alter the percentage of healthy seedlings expected. A separate germination room or "sweat box" is often used, reducing the energy input considerably and resulting in more-uniform seedling emergence. Constant supervision is required.



1. dimmer/on-off switch to regulate temperature
2. check light
3. food-warmer plate
4. cake pan for water
5. seed sack (more than one can be treated at a time)
6. probe thermometer
7. 4-mil or 6-mil (preferable) plastic covering for entire box
8. lath framing
9. 4-mil or 6-mil (preferable) plastic door
10. screen-wire shelf or old refrigerator shelf (more than one can be inserted)
11. single piece of plywood
12. hooks to hold door shut

Figure 7. "Sweat chamber" for seed pre-germination

Procedure

Pregerminating seeds: 1. Suspend seeds loosly in a cheesecloth bag or tea strainer. 2. Soak in hot tap water for 2 hours (not over 50°C [122°F]). 3. Add vermiculite (3 × volume) to soaked seeds (to achieve a better distribution of seeds, to guarantee even moisture, and to guarantee aeration and prevent "drowning." 4. Place the mixture very loosely in a plastic bag; close the bag tightly. 5. Place the plastic bag in the "sweatbox" shown here (a hot water heater closet or a room not over 30°C [89°F] may be used instead). 6. Maintain 100 percent humidity. 7. Check for germination (show of radicle) after 24 hours — repeat checks every 4 hours. 8. Fill the water pan daily. 9. Most cultivars show radicles after 48–54 hours, but each cultivar and seed lot has to be tested in small amounts previous to final seeding. *(After Muehmer & Brimner 1982)*

Soil and media temperatures under any protective cover vary considerably; therefore, an accurate soil thermometer should be used frequently. Except for lettuce, supplemental light is of no benefit to most vegetable seeds.

The covering of freshly sown containers with clear plastic to prevent drying out can easily result in overheating. The use of opaque colored plastic is much safer and results in better seedling stands. Very beneficial is the use of perforated plastic film, such as Viscount, Seed Bed Cover or similar material, but only during early stages of seedling growth. Only fine nozzles or misting heads should be in use for watering seed flats.

Seeding and Spacing

The most-common seed and plant spacings are given in Tables 3 and 4. Broadcasting of seeds generally is not too commonly used, unless a system of

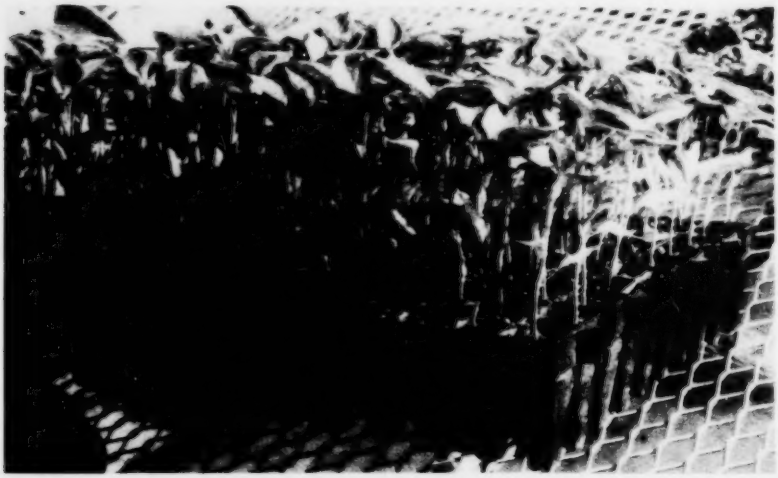


Figure 8. Uniform growth of pepper seedlings is achieved by pregerminating seeds in trays such as this plastomer-200 tray, placing units in "Sweat Chambers" for 5 days at 25°C.

even seed distribution is employed by using pregerminated (with 2–3 mm radicle showing) seed uniformly scattered on the media surface. These seedlings stay in place until lifted as plants for field setting.

Most seed is sown in rows (distances are given in Table 3) for better, more uniform growth and easier lifting and seedling separation. Seed rows are conveniently pre-pressed for uniformity in depth and row distance, then covered with the medium used in the tray or with sand, shredded peat, soil, vermiculite or crushed rock. Very light materials will float away with watering, exposing the seeds just planted. It is important to include a fungicide with the first watering to prevent damping-off organisms from developing. Materials in common use are Captan, Benlate, Easout, Truban. Follow label instructions accurately.

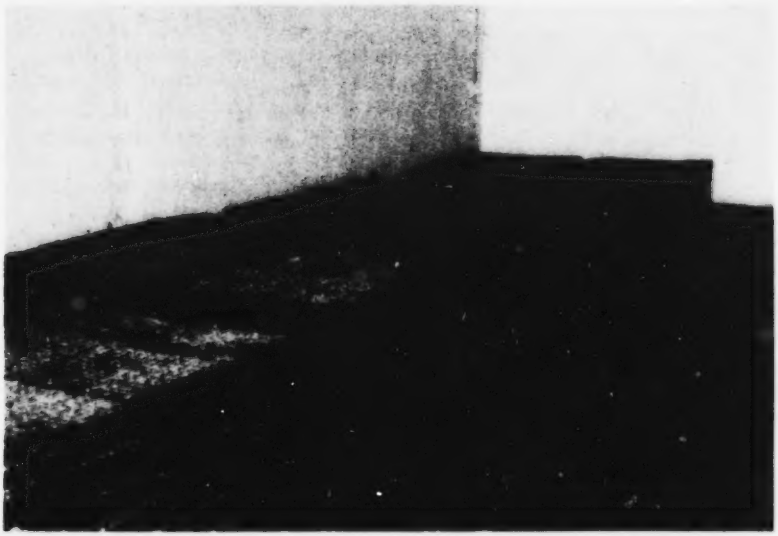


Figure 9. Commercial-size germination room with "plug-trays" stacked and off-set up to 25 flats high on pallets placed on heated concrete floor.

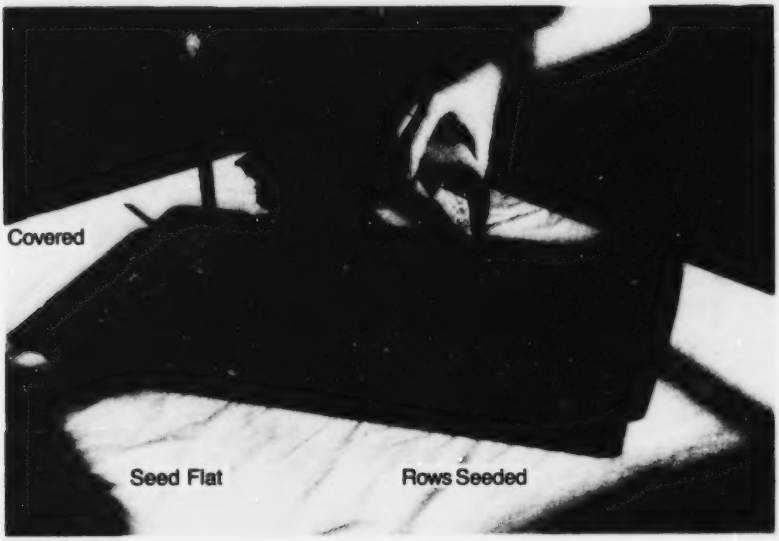


Figure 10. Seed sowing out of the package or with the assistance of a battery-operated vibrator provides even seed distribution. After placement, rows are covered with an appropriate material. (left side of flat).

TRANSPLANTING SEEDLINGS IN GREENHOUSES

Starting seedlings in confined areas such as hotbeds or special greenhouses conserves space and increases the economics of plant production. As seedlings become crowded, they should be transplanted from the seedling flats into the various sized and shaped containers to be used for different crops at the optimum spacings as recommended in Table 4.

Figure 11. Plants are gently lifted from the seedling flat and carefully separated for transplanting. Damaged and malformed seedlings should be discarded.

Actually, transplanting seedlings is injurious and not beneficial to the plants. The degree of set-back to plant growth depends on the amount of root injury, seedling age, plant size and type of vegetable crop as well as on the growing conditions immediately following the procedure.

Seedlings of certain crops such as vine crops are most difficult to transplant successfully (see Table 3) and are, therefore, sown directly into individual cells or containers.

The careful handling of the small seedlings requires a certain skill — hold seedling by the seedleaf, not by the stem (Figure 12). The best stage to handle most vegetable seedlings is when the first true leaf is visible between the cotyledons. Always discard damaged, malformed and weak seedlings. Keeping the freshly transplanted flats shaded and moist guarantees faster establishment of the young seedlings.

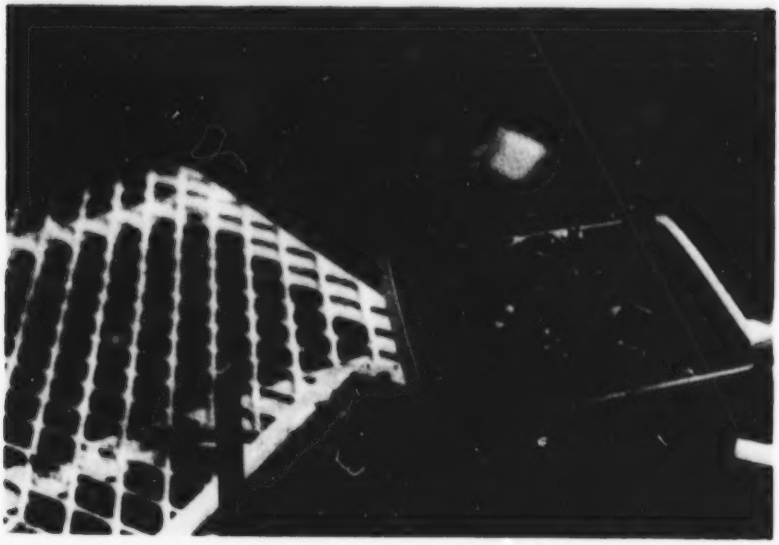


Figure 12. Never handle seedlings by the stem, but rather hold the plant in place by a leaf or cotyledon. The slightest injury to the stem results in permanent damage.

The increased cost of transplants, particularly for processing vegetable crops, has caused a shift toward direct flat seeding, eliminating the steps involved with transplants. The use of small-celled containers (plugs) will find increased future use. (See Section on plug-growing.)

CONTAINERS FOR PLANT GROWING

Container-grown transplants are convenient, attractive and practical not only for the plant grower, but for the middleman and customer as well. These containerized plants in their individual cells suffer least from transplant shock, as the roots are undisturbed and plants will, therefore, continue to expand and rapidly grow once field set. Plant cells are a must when transplanting vine crops to the field. Without root balls these seedlings are bound to fail.

There is a multitude of container sizes and shapes on the market (Figures 14, 15, 16). Each offers certain advantages. The market situation as well as the practicality for the plant grower will determine the most suitable type and size for the least cost. Container-grown transplants are most useful for the retail trade, while bulk loads of plants for large vegetable operations are usually grown in ground beds (if cheap labor is still available), or in reusable containers such as flats or

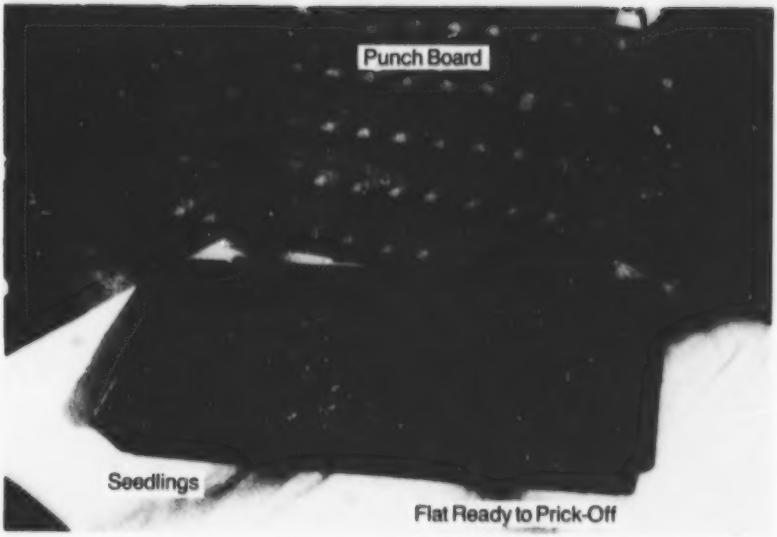


Figure 13. Punch board commonly used to evenly space seedlings in transplant flats.

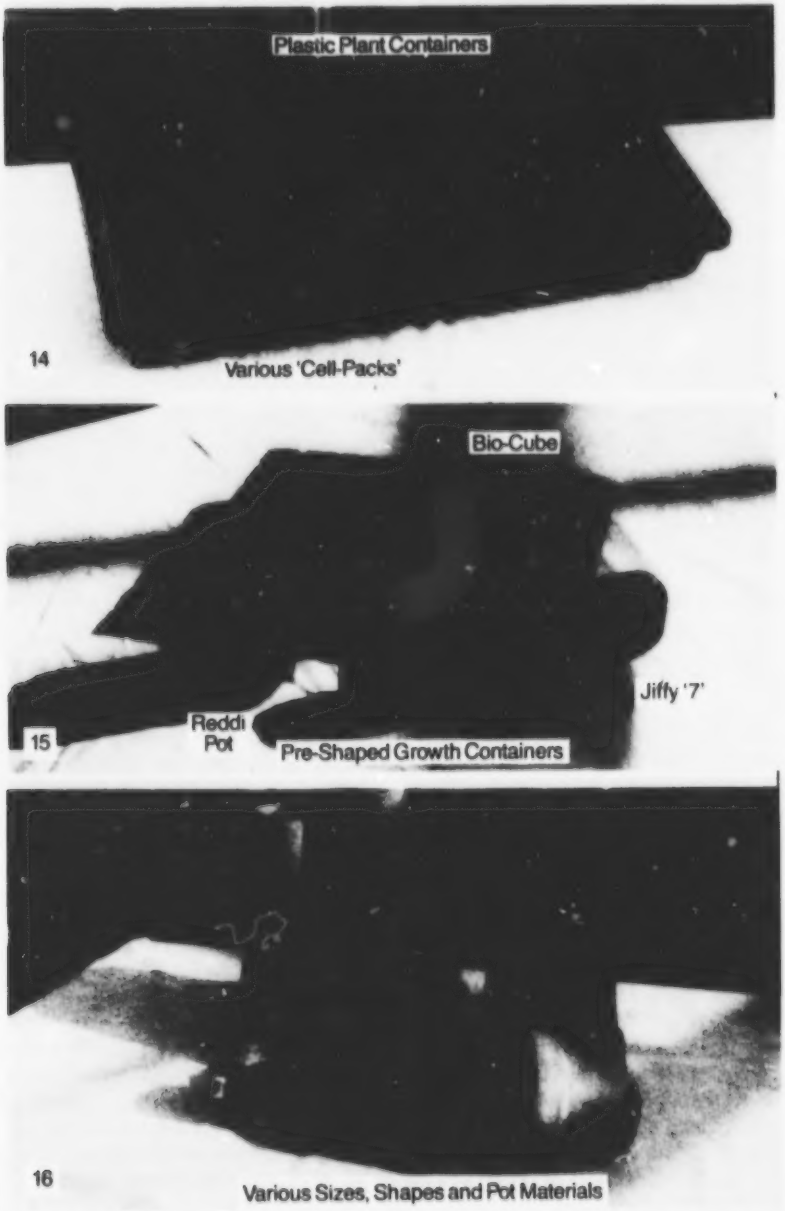
trays made of plastic or wood, (to be sterilized after each use), on styrofoam or plastic multi-celled trays. Soil blocks are a very practical means of raising plants in individual cells, but so far the industry has not adopted this system to any great extent.

GROWING PLUGS

Introduction

Local transplant growers have, until now, relied on the ground-bed system of plant production. This system is very labor intensive and is not competitive with imported plants in terms of earliness, price and plant quality for the large plantings needed to supply the processing vegetable industry.

The Ontario vegetable industry requires an alternative method of raising transplants. The system which appears to be most economical involves growing plants in greenhouses at **high plant populations**. The plants are grown in plug-type trays similar to those used for bedding-plant flower production. Plug trays are molded plastic, divided into uniform individual cells or "plugs." Plug size influences transplant performance in the field. Table 5 and Figure 21 illustrate recommended cell sizes for various crops.



Figures 14, 15 and 16. There is a multitude of container sizes, shapes and materials available, each designed for a specific crop and definite purpose.

Figure 17. Well-developed tomato transplants in "288" plug trays in properly ventilated greenhouse.

As this system presents a new method of raising transplants, it is discussed in considerable detail.

1. **Growing Media** Use a commercially prepared soilless mix. When selecting a mix, consider the following factors:
   — **pH** — Desirable range is between 5.0 to 6.5. Have a pH test done before seeding.
   — **Soluble Salts** — Levels of soluble salts vary depending on the amount of fertilizer in the commercial mix. Have the mix tested for salts before seeding. Avoid using a mix with excessively high salts. Acceptable range for seedlings is between 0.2 and 0.8 millisiemens for actively growing transplants. (Analyze salts via the Saturated Paste Procedure.)
   — **Fertilizers** — Mixes holding low levels of fertilizers containing minor elements are preferred, but not essential; nutrients can be applied with each watering if necessary.

Drainage and water retention It is important that the growing medium is maintained at a uniform moisture level. Select a mix with a medium particle size to ensure proper aeration, drainage and ease of filling trays. While preparing the mix, adding a wetting agent such as Aqua-gro or Viterra will improve water penetration. (Most commercial mixes contain a wetting agent.)

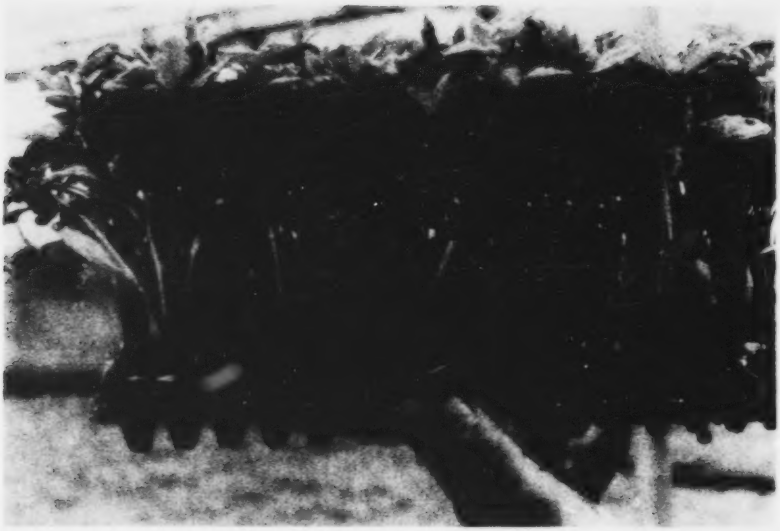


Figure 18. Properly grown "288" plug flat which was elevated off greenhouse floor facilitating "root pruning". (Sutton-tray).

The following mixes have been tested and appear to be well suited for plug plant production: Pro Mix A; Metro Mix 200; ASB; Pro-Mix C. Other mixes may be equally satisfactory.

Table 5 Suggested Plug Tray Sizes for Vegetable Transplants

	No. of Cells/Tray				
Crop	288 242	200 Plug	200 Seedling	162 or 128	72*
Processing Tomato	X	X			
Fresh-Market Tomato		X	X	X	X
Cole Crops		X	X	X	X
Peppers		X	X	X	X

* *Larger cells, such as 50, 38 or 24 cells/tray are also acceptable for fresh-market transplants.*

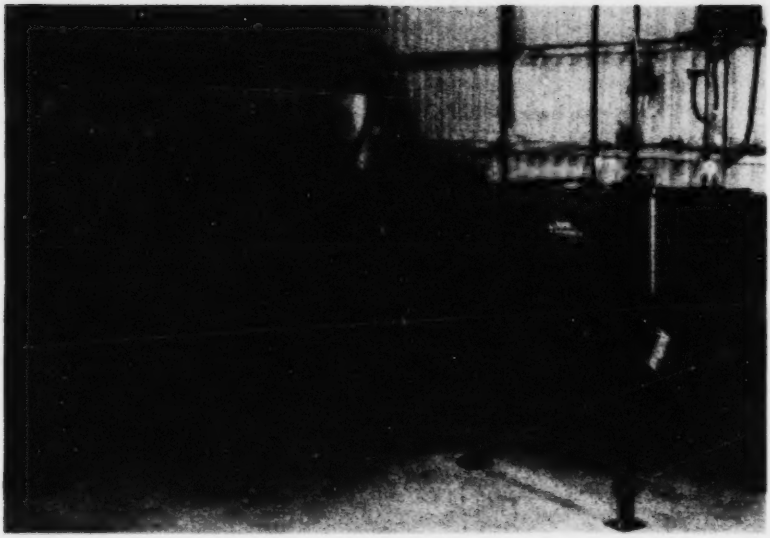


Figure 19. Automated flat filler with dibbler, seeder — where seed is covered, moistened, and a fungicide applied before entering the germination chamber.

2. **Seeding** A number of tray seeders are commercially available. Choice of a seeder depends on the grower's anticipated volume of production. Singulation of the seed is desirable, but a small percentage of doubles is acceptable. The mix should be moist at seeding time. Covering seeds with vermiculite or other similar materials will improve moisture retention and emergence. To ensure good root "pegging" a depression in each cell prior to seeding is essential. This can be accomplished with a commercial dibbler or by placing one tray into the other after filling and pressing slightly.
3. **Seed** Be very selective in the choice of seed. Only the very best quality of sized seed from selected seed lots is good enough for growing in plugs, where a perfect stand makes the operation viable. With the advent of enhanced seeds such as Bio-Tech, Hi-Tech and Superfax seeds, the choice is made easier.
4. **Germination** Optimum germinating conditions vary depending on the crop. See Table 1 for a description of these conditions. Adequate media moisture must be maintained during germination. The use of a germination chamber may be desirable to maintain optimum conditions, particularly for larger operations. It is of great advantage to have warm-season crops, such as tomatoes, peppers and eggplants particularly, exposed to warm temperatures around 29°C to break dormancy. Constant monitoring of the optimum temperature within the medium is necessary. Radicles (small roots) often

show after 48 hours in a "sweat box" or germination chamber. With the **first sign of a white radicle** or root breaking through the surface, **remove treated flats at once** and transport them to the growing house without chilling. Part of a greenhouse sectioned off with plastic and maintained at a higher temperature is also beneficial and will pay off by reducing growing time and increasing emergence.

5. **Disease Prevention**
   (a) Seed should be treated with thiram before seeding.
   (b) *Damping off* should not be a problem if growers are using treated seed and sterilized soilless media and maintain adequate ventilation in the greenhouse. As a preventive measure, a spray of captan fungicide (at the label rate) may be applied when the plants have emerged and are growing well. **Do not apply captan as a drench immediately after seeding as this may reduce emergence.**
   (c) The growing plants should be carefully monitored for diseases. Spray diseased areas with a suitable fungicide such as captan at label rates.
   (d) Spray programs for disease prevention will vary depending on the crop. On tomatoes, spray with a fixed-copper bactericide tank-mixed with either mancozeb or maneb at 11 g of each product per 50 m^2. Start spray when true leaves develop and repeat every 7 to 10 days. Use a fine spray to prevent splashing and spreading of disease. **Do not use fixed copper on cauliflower seedlings.**
6. **Placement of Trays in the Greenhouse** The trays should be suspended so the roots cannot grow through the bottom of the plugs (air root-pruning) as this causes difficulty in pulling plants. It is important that the trays are level to prevent water from running into low spots. (See Figure 3.)
7. **Growing Temperatures** Optimum growing temperatures vary depending on the crop. See Table 1 for optimum growing temperatures. Adequate ventilation is important to control growth and prevent diseases.
8. **Watering** Previous to the growing season, it is strongly suggested to have a **detailed water analysis** in order to make necessary adjustments and to prevent problems occurring, e.g., with high pH levels or precipitate of phosphates. Maintain an adequate and uniformly moist media, but do not overwater. Use low water pressures to prevent damage to the seedlings.
   An automated watering system is desirable.
9. **Fertilization** Fertility programs for plug plants will vary depending on the type of mix used and the growers individual management system. A feeding program should be started once seedlings are established.
   Fertilizer application should be evenly distributed over time. Applications may be made at every watering or not less than twice each week. Weekly applications will probably result in reduced growth.

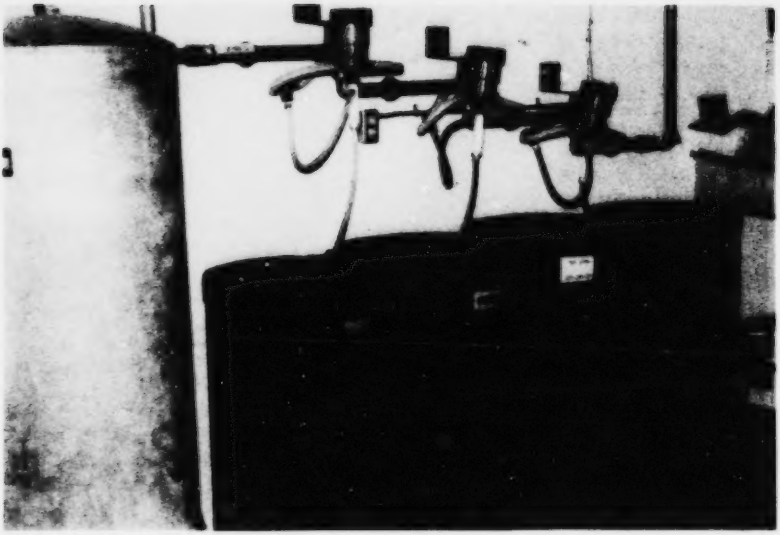


Figure 20. Stock solutions of various fertilizers to be used with injection system in larger operations.

A complete fertilizer such as 20-20-20 with trace elements or similar formulations is recommended.

Two suggested fertilizer programs for vegetable crops are outlined below.

The above rates are sufficient for good growth. Growers should adjust rates slightly upwards in accordance with stage or plant growth. Overly high rates of fertilizer will result in salt damage and reduced growth.

Sample calculation of parts per million of nutrient

1 litre of water weighs 1 kilogram (1000 grams).
Therefore 1 gram of fertilizer in 1 litre of water =

$$\frac{1\text{ g}}{1000\text{ g}} = \frac{1000}{1{,}000{,}000} = 1000 \text{ ppm of product}$$

Example #1:

Calculate the amount of 20-20-20 product required to make up a 100 ppm of actual nitrogen solution. The fertilizer 20-20-20 contains 20% actual nitrogen.
You will require $\frac{100}{20} \times 100 \text{ ppm} = 500 \text{ ppm}$ of the product 20-20-20 to deliver 100 ppm of actual nitrogen.

Therefore 500 ppm $= \frac{500}{1{,}000{,}000} = \frac{.5}{1{,}000} =$ .5 g of 20-20-20 per litre of water

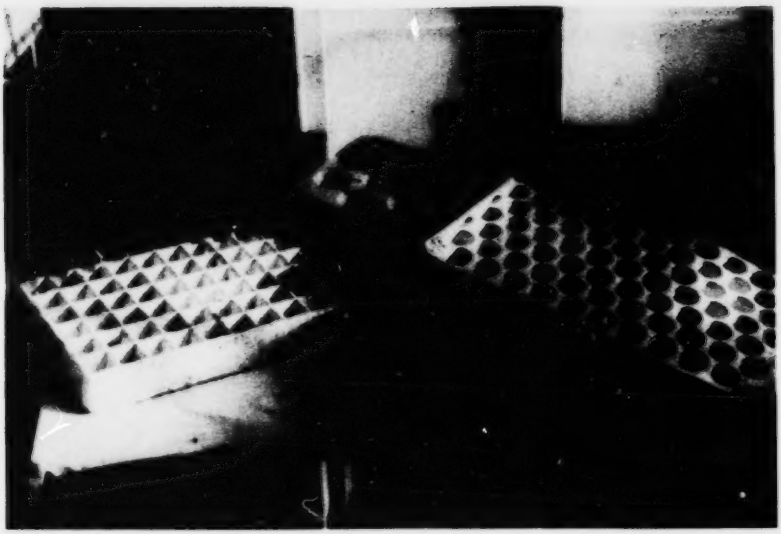


Figure 21. Most commonly used plug tray sizes.

Example #2:

Calculate the amount of 20-20-20 required to make up a 350 ppm of actual nitrogen solution.

$$\frac{100}{20} \times 350 = 1{,}750 \text{ ppm} = \frac{1{,}750}{1{,}000{,}000} = 1.75 \text{ g of 20-20-20 per litre of water}$$

Modern systems with automated or computerized watering/feeding equipment can easily implement this type of schedule. For older established operations where a proportioner-injector is used, Chart 1 will make it easier to add the desired fertilizer to the young seedling transplants.

Stage of Plant Growth	Program #1 Feeding every watering	Program #2 Feeding twice weekly
	Parts per million of nutrient (N, P, and K)* applied per feeding	
Emergence to first true leaf stage	50 ppm	150–200 ppm
First true leaf to finished plants	200 ppm	350–500 ppm

* *N-Nitrogen, P-Phosphorus K-Potassium*

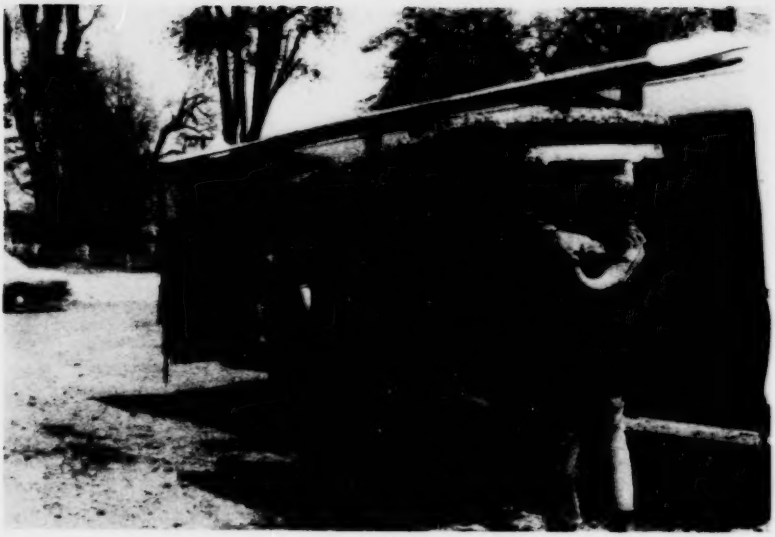


Figure 22. Special covered wagon to transport plug-tray plants on racks to the field.

Chart 1. Ounces of Fertilizer Required per Gallon of Concentrate (for proportioner-injector feeding)

TO USE THIS CHART:

1. Select your injector's ratio setting across the top of columns.
2. Select percentage of N of plant formula used in left column.
3. Read across and down to find ounces required per gallon.
4. Multiply this amount by the number of gallons of concentrate used in your proportioner.

N analysis of Fertilizer (% N)	To Make 100 p p m. nitrogen at an Injector Ratio of:					
	1:30	1:50	1:100	1:150	1:200	1:400
5	8.1	13.5	27.0	40.5	54.0	108.0
10	4.05	6.75	13.5	20.25	27.0	54.0
15	2.7	4.5	9.0	13.5	18.0	36.0
20	2.03	3.38	6.75	10.13	13.5	27.0
25	1.62	2.7	5.4	8.1	10.8	21.6
30	1.35	2.25	4.5	6.75	9.0	18.0
35	1.15	1.93	3.86	5.79	7.71	15.42

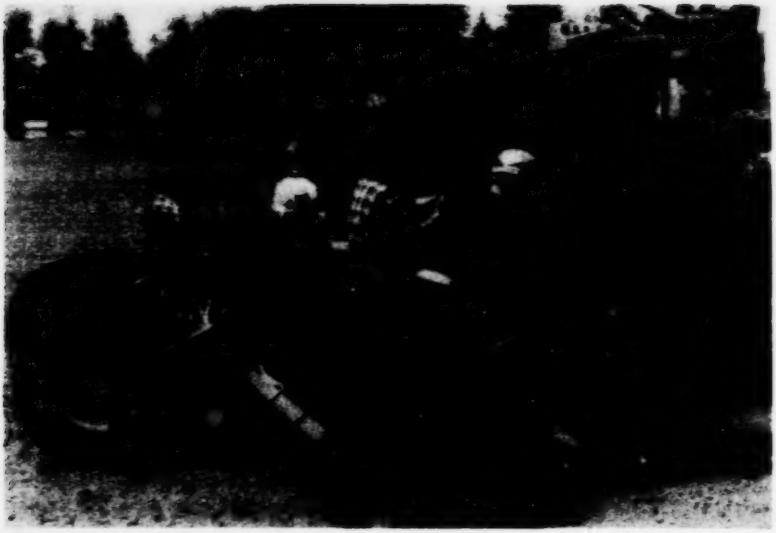


Figure 23. Three-row "plug" planter with plants easily accessible by operators in trays standing upright on end.

It is recommended to check the pH levels in the growing media at weekly intervals and execute necessary adjustments, thereby preventing damage to delicate plug transplants.

Table 6. Optimum germination and growing temperatures for various crops[1]

Crop	Germination Temperature (°C)	Growing Temperature Daytime (°C)	Growing Temperature Nighttime (°C)
Tomato	29	18–21	16–18
Pepper	29	18–21	16–18
Cole Crops	26	13–18	10–16
Celery	21	18–21	16–18
Vine Crops	32	21–24	16–18
Onion	24	16–18	13–16

[1] *From Knott's Handbook for Vegetable Growers.*

10. **Hardening Off** Maintain adequate ventilation and reduce temperature where possible. Reduce watering and feeding schedules. Prior to field setting resume normal feeding program, and water to saturate plugs.
11. **Shipping and Handling** Protect plants from exposure to drying winds. Constant monitoring and watering is required. A delay in field setting may require that the plants be returned to the greenhouse and watered again.

General Comments

It is just as important to have control over the plant environment as it is to ensure that plants receive sufficient nutrients.

Proper growing temperatures at specific stages of growth is one of the major criteria, along with timely watering schedules, for obtaining the desired plant growth. Poorly and improperly applied nutrients cannot correct previous mistakes in ventilation and watering procedures.

GREENHOUSE MANAGEMENT

Greenhouses or hothouses represent a controlled environment, where skillful management of temperature, ventilation, fertility, irrigation, relative humidity and, to some extent, CO_2 and light lead to production of healthy plants or of specialized crops with highest returns per capital invested.

Light

Light provides the energy source to trigger photosynthesis and initiate plant growth. Except in flower crops and in raising seedlings, there are no economical systems which provide adequate artificial lighting to grow commercial volumes of plants or crops. The withholding of light (i.e., shading) for specific purposes and crops is a better alternative. The lack of light presents a problem during certain periods of the year and limits plant growth. The skillful balancing of temperatures, CO_2, fertilizer and watering must counter this problem.

Temperature and Ventilation

Different vegetable crops vary in their optimum temperature requirements. The ranges are given in Table 4. Low light levels naturally require a drop in temperature. Temperatures lower than recommended ranges result in reduced growth and delayed plant development. Physiologically, this will be the cause of rough fruit in tomatoes, misshapen peppers, bolting and buttoning in cabbage and cauliflower, respectively.

Invest in accurate thermometers and locate them strategically in the plant-growing house at the proper plant-growing level. Refer to them frequently unless the facility is automatically controlled. Uniformity of temperature and humidity are essential for good plant growth and should be controlled by ventilation and adequate air circulation within the growing house. This is achieved using either perforated, air-inflated polyethylene tubes which generate an even air distribution, or circulating ceiling fans. Some ventilation, particularly circulation, helps in reducing moisture build-up (sweating) and, therefore, reduces the likelihood of

disease. Cold drafts should be avoided since plants not only get chilled but dry out more frequently, resulting in a non-uniform stand. Plastic-covered structures need more ventilation than glass houses. It is a common mistake to economize on fans and proper-sized vents. The fans must be large enough to facilitate a complete air change every minute, air should not have to move more than 35 metres.

Watering

One of the most difficult procedures in any greenhouse operation is the proper regulation and extent of watering, an art which can only be acquired over years of practice, a feel for the plants and knowledge of plant growth requirements. Water plants only when moisture is needed — and then moisten the soil very thoroughly. A common error is over-watering, resulting in soft, succulent plants with poorly developed root systems, often associated with root and stem diseases.

Automated sprinklers or mist systems are used fairly extensively now. They are only as good as the operator who sets them up, makes adjustments and regulates them to suit the specific needs of the type of crop produced under a certain set of growing conditions.

Relatively porous growing mixes such as soilless and peat-lite mixes need water more frequently but, due to easy water percolation, result in superior root development which in turn produces better plants.

As a general rule, water plants well in the morning, permitting the foliage to dry quickly, and prevent heavy watering late in the day which can easily initiate diseases. Water sparingly on cloudy and rainy days.

Spacing

Unless special mini-cells are in use and treated accordingly (as discussed under the plug section), one should avoid close spacings where plants compete for light, nutrients, and moisture. Details for early transplants are found in Table 4. Extra-wide spacings used for early fresh-market tomatoes are only economical under extra favorable climate conditions, when premium prices can be demanded for early-marketed, superior-quality fruit.

Fertilization

Growers still using a soil-sand-peat mix require few, if any, additional nutrients for most of the 5 to 7 weeks transplants are under protective cover. A "boost" a few days before field setting, using soluble 20-20-20, 10-52-17, or 10-52-10 fertilizer, will definitely improve plant quality in the field.

Plant growers are required to recognize deficiency symptoms on seedlings. If uncertain, ask advice from a special crops advisor to correct the problem.

Some growers supply extra nutrients when preparing their mix. Others add trace elements only, along with slow-release fertilizers. The use of mini-pellets is only advisable for the latter to guarantee better distribution of the nutrients, particularly in small cells and mini-plugs.

Good crops can be grown from the mixes just mentioned; however, it is much easier to maintain control by feeding soluble fertilizers either by hand, via a syphon apparatus, or ideally with an automated fertilizer injection system. With

this system, one distributes a pre-mixed amount of nutrients evenly with the irrigation system, once weekly, bi-weekly, daily or with every watering. Research has proven that nutrients supplied in small amounts with every watering is the most effective and economical method for cost-efficient plant raising.

Plant Hardening and Cold Treatment

In this physiological process, plants accumulate extra carbohydrate reserves, enabling them to withstand harsh field conditions and recover more quickly after field setting. This hardening process can be accomplished by lowering temperature, reducing water and/or limiting fertilization. A few days of checking plant growth in this way is beneficial. Prolonged periods of hardening may be detrimental as these transplants, once field set, begin growth slowly and may never fully recover. With certain species, such as cauliflower and other biennials, such cold treatments induce premature seedstalk formation and show other undesirable traits.

Procedure for Cold Treatment of Tomatoes

Only growers of fresh-market crops in the extreme southwest of Ontario are using this method when growing their own transplants. This system is more labor intensive and requires additional growing space. Also, growers must start 10 to 14 days earlier than usual.

1. Tomato seed is germinated at 24 to 27°C (75 to 80°F) in flats of sterilized soil or whatever sterile medium is used for growing young seedlings.
2. When the **first** true leaf of the seedling appears, the plants are grown at a minimum night temperature of 10 to 13°C (50 to 55°F) for three weeks. They can receive the cold treatment either before or after the first transplanting. The plants should be exposed to as much sunlight as possible. This may cause the day temperature to occasionally rise well above 10°C; however, the response of the chilling treatment will not be affected if the night temperature remains between 10 and 13°C.
3. After **three weeks of cold treatment**, the plants are grown at the recommended temperature of 16 to 18°C (60 to 65°F). The seedlings should be pricked-out now if given the temperature treatment while in the seedling flat.

Procedure for Cold Treatment of Peppers

The number of flowers and fruits on the plant can be increased by exposing the seedlings to a controlled cold treatment, as follows:

1. Germinate seed at 27 to 29°C (80 to 85°F) in flats of desired medium.
2. When the **third** true leaf of the seedling appears, grow the plants at a minimum night temperature range of 12 to 13°C (53 to 55°F) for four weeks. The plants can receive the cold treatment either before or after the first transplanting. The plants should receive as much sunlight as possible. After **four weeks of cold treatment**, grow the plants at the recommended temperature of 21°C (70°F).

PEST MANAGEMENT

Cleanliness and Sanitation

Sanitation is a first step in any program to control diseases, insects or weeds in plant-growing structures. If a source of infection is constantly present, pest control programs will never be totally successful.

To keep plant-growing houses clean, remove and destroy all dead plants, old flats, weeds, boards, etc. that may harbor insects, weeds or disease organisms.

A five-metre strip of carefully maintained lawn around and between greenhouses will decrease the danger of invasion from insects and diseases that may otherwise harbor in adjacent weed growth. To prevent disease organisms from carrying over between seasons and different crops, spray the empty structure a few weeks before starting the seedling crop with: (1) 10% sodium hypochlorite solution — 1 part hypochlorite to 9 parts of water, or (2) 37% formalin solution — 30 litres to 1000 litres of water.

Similarly, treat all benches and equipment within the greenhouse. Immediately after spraying, close the greenhouse for 3 or 4 days, then ventilate. CAUTION: Wear an approved respirator when spraying with formaldehyde or sodium hypochlorite. For information on respirators refer to the Protective Clothing Section in OMAF Publication 365, *Pesticide Recommendations for Greenhouse Crops*.

Pasteurization of the Growing Media

Greenhouse and field soils contain weed seeds, insects, bacteria and fungi which may be harmful to the plants to be grown. This includes potting mixes, peat-lite mixes and their components, unless they are guaranteed sterilized or pasteurized by the manufacturer. Soil mixes for vegetable transplants can be pasteurized to eliminate these harmful organisms. Ideally, this is accomplished without injuring beneficial soil organisms. The media should be of fine tilth to allow rapid, uniform penetration of the steam or fumigant. It should be free of clods, large lumps and undecomposed crop remains.

Methods

1. Steam is a very reliable source of heat for pasteurization of the growing media. There are several different ways of handling steam. When pasteurizing soil for vegetable seedlings, growers find it quite efficient to inject steam into the bottom of a wagon or old truck body. Another method commonly used when the seedlings will be grown in wooden flats is to place the soil in the flats, pile them up with slats between the layers of flats to provide steam and air penetration, cover the flats with a plastic "steam tarp" and inject the steam underneath. If seedlings are to be grown in ground beds, the steam can be injected through a canvas hose, directly under a pan or tarp, covering the bed. For custom operators, steaming growing structures is an economical way to get the job done efficiently. The following chart gives an idea of the time-temperature relationships necessary to destroy undesirable organisms.

Weeds (most)	70° - 80°C for 15 min.
Insects & Mites	60° - 71°C for 20 min.
Bacteria (most)	60°C for 10 min.
Fusarium	57°C for 30 min.
Botrytis	55°C for 15 min.
Nematodes	55°C for 15 min.
Rhizoctonia	52°C for 30 min.
Sclerotinia	50°C for 5 min.
Pythium	46°C for 40 min.

Note: Pythium, Rhizoctonia, Botrytis and Fusarium are fungi that are commonly found in soils which either alone or in combination can give rise to damping-off. This is one of the most serious disease problems in vegetable seedlings.

Figure 24. Electric soil pasteurizer with automatic temperature shut-off and timer.

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2. Electric soil pasteurizers (Figure 24) are useful where small volumes of soil are used. Over-cooking of the soil can occur very easily because, in order for the temperature between the finned heat source to reach 82°C, the fins themselves must be at a higher temperature.

3. Soil Fumigation. Metam (Vapam), dazomet (Basamid) and Vorlex when applied to the soil produces a gas killing most weed seeds, nematodes and plant disease organisms which cause damping-off and other seedling diseases. They are useful, therefore, in treating seed and potting soil. Methyl bromide is also a good soil sterilant requiring a gas-proof plastic cover to seal in the active fumigant. Only experienced and licensed operators should attempt to use methyl bromide, because it is very poisonous to man and livestock. The use of methyl bromide is subject to the Pesticides Act (1973) and Regulations requiring that a permit be obtained from the local Pesticides Control Officer of the Ontario Ministry of the Environment each time it is used.

   Additional information is available in OMAF Publication 365, *Pesticide Recommendations for Greenhouse Crops*.

Seed Treatment

1. Chemical Seed Treatment

All seed for vegetable transplants should be treated with a fungicide to help prevent seed decay and damping-off. In many cases, this has been done by the seed company before the seed is packaged and, if so, the package will indicate this. If untreated seed is purchased, it is advisable to apply a fungicide before planting as per methods outlined in OMAF Factsheet 250/23, *Vegetable Seed Treatment*.

2. Hot-Water Seed Treatment

This is best described in OMAF Publication #363 and the Factsheet mentioned above.

TRANSPLANTS IN GROWER FIELDS

Imported (Southern) Transplants

The processing vegetable industry particularly relies heavily (95%) on transplants grown in the southern United States, mostly in Georgia, Florida, and North and South Carolina. Due to their favorable climates, these states can produce excellent-quality plants from fields sown in March without using protective covers. The difficulties with southern plants arise from:

(a) Inclement weather during the critical plant-growing period
(b) Diseased seed source
(c) Contaminated fields
(d) Improper methods and time of pulling (harvesting) transplants
(e) Incorrect handling of transplants while packing and shipping
(f) Long-distance hauling

The plant-growing industry is trying hard to streamline this sytstem and attempt to overcome these difficulties. An exchange of information and research has helped to produce a better "stick" (bare-root) southern plant. It is most difficult for local growers to compete successfully with these long-time, experienced plant growers, particularly if Mother Nature is in their favor.

Figure 25. Sorting through southern bare-rooted transplants to eliminate those that are poorly developed, broken and diseased.

High-Density Planting

Compared to traditional plant populations for vegetable transplants, recent trends for several major crops are towards high densities. New tomato cultivars are compact plants which have their highest yield potential when spaced closely, or even when twin-rowed. Instead of 21,700 pl/ha (8,700 pl/A) most farmers plant over 33,750 pl/ha (13,500 pl/A), particularly in a machine-harvest operation. Similarly, plant distances in broccoli are reduced by half, as the market place demands a bunching of 2 to 3 curds instead of one large head. Although transplant costs have increased by adopting these practices, growers have adapted to new systems using high-density plant populations in a responsible way, and kept production costs reasonable.

Success Rate of Transplants

Easy to Transplant	Moderate	Difficult
Tomato	Pepper	Vine crops
Cole Crops	Eggplant	Corn
Lettuce	Onion	
Sweet potato		

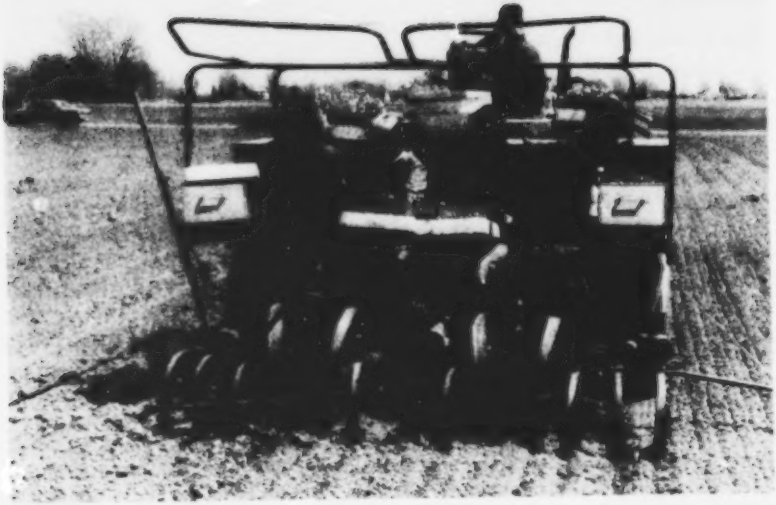

Figure 26. A 2-row mechanical transplanter field-setting cabbage plants using speedling plants.

Mechanical Transplanters

Basically, a transplanter is designed to open a furrow and place water (with or without fertilizer added) in an opened row around the roots of a plant which has been dropped or mechanically placed in that opening. The plants still have to be placed into pockets of cups by hand. Mechanical transplanters are only mechanical planting aids. Prototypes of completely automated transplanters have been tried at various locations with mixed success. It still requires a certain amount of skill from the farmer to adjust this machine for the proper placement of transplants in the ground, and from the operator(s) to place plants in a certain way into planter pockets or cups to successfully field-set transplants guaranteeing a high success rate or "take".

Like any other machines, tranplanters need constant adjustment when soil type changes. They also need regular maintenance, particularly cleaning of rubber fingers, pockets, chain drives and sprockets.

Plant Protectors

Plant protectors, in effect, are miniature greenhouses placed over entire rows or single plants. Due to high labor and material costs, few of the devices such as hot caps, plastic sleeves, waxed-paper sleeves, glassine paper cylinders, etc, are used these days in any quantity. Not only is the placement of the protective devices over plants time consuming, but removal on warm spring days to

prevent overheating and the necessary re-placement at night make the use prohibitive for most operations.

Row Covers and Mulches

Recently, there has been repeated interest in the use of row covers, likely due to the more severe competition with vegetable-growing regions close to urban concentrations, and the willingness of many city dwellers to pay a premium for local, high-quality produce.

Row covers of polyethylene film, often now equipped with air slots or perforations, are rolled out and supported by wire hoops placed at 45 to 60 cm intervals over bare soil, or mulch-covered ground. The edges of the row covers as well as mulches are tucked-in with soil, to prevent wind from lifting them off. The extra cost of such mulch very seldom can be justified by greater yields. Despite the availability of complete mechanization, considerable labor is involved securing edges and continually guarding against overheating, if necessary by providing appropriate aeration.

Mulches

Like row covers, mulches conserve moisture, provide weed control and accelerate maturity by increasing soil temperatures during the day as well as decelerate the cooling-off during night time. All these factors combined result in better-quality produce and increased yields. This is true for most crops, but particularly dramatic with vine crops.

Tractor-mounted mulch layers of different designs are available, but all are capable of covering the edges of the mulch with soil. Several models of mulch-layer/transplanters (or seeders) are also on the market.

Most mulch materials in use are black or dark-brown polyethylene materials, but some brownish-color biodegradable plastics are in use as well, in rolls 1 to 1.25 m wide. The latter have the disadvantage that breakdown can occur at an inopportune time depending on weather conditions. Also, the covered edges do not break down, become a nuisance to the farmer and have to be removed like other plastic mulches, after cropping.

Clear, transparent mulches are in use as well, actually benefitting plant growth most, but excessive weed growth underneath prohibits any practical use.

Even in regions where very large areas of mulches are in use for most crops (Florida, Georgia, California), additional fertilizer applications not only are impractical to administer but have been found to be unnecessary.

Direct Seeding

Only a small percentage of the vegetable production in south-western Ontario is direct seeded. The main advantage is the low cost of establishing a high plant population with minimal production input. Considerable skill and special equipment are needed to successfully produce a crop every year.

Crops recommended for direct seeding are tomatoes, cucumbers, muskmelon, squash, cole crops and asparagus.

Better-than-average land preparation is necessary, and each crop requires specific details which should be discussed with the OMAF crop advisors for each area.

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